CENWW-ODH FONE 20 January 2023

MEMORANDUM THRU:
Brian Vorheis, Operations Project Manager, Ice Harbor Dam

FOR Chief, Operations Division
ATTN: Chris Peery / Scott St. John

SUBJECT: Submission of 2021 Adult and Juvenile Fish Facility Monitoring Report, Ice Harbor Dam.

1. Enclosed is the 2021 Adult and Juvenile Fish Facility Monitoring Report for Ice Harbor Dam as requested.

2. If you have any questions contact Ken Fone at Ice Harbor Dam, (509) 544-3137.

Kenneth R. Fone
Fisheries Biologist, Ice Harbor Dam

Enclosure

2021 ADULT AND JUVENILE FISH FACILITY MONITORING REPORT

ICE HARBOR DAM

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January 2023

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List of Acronyms

BPA – Bonneville Power Administration
CFS – Cubic feet per second
FPC – Fish Passage Center
FPP – Fish Passage Plan
JCC – Juvenile Collection Channel
JFF – Juvenile Fish Facility
KCFS – kilo cubic feet per second
NFL – North shore fish ladder
OOS – Out of service
PDS – Primary dewatering structure
PLC – Programmable logic controller
SFL – South shore fish ladder
STS – submersible traveling screens
RSW – removable spill weir
USDA-WS – United States Department of Agriculture-Wildlife Services
VBS – vertical barrier screen

Summary

This report summarizes the operation and maintenance of the adult and juvenile fish passage facilities at Ice Harbor Dam in 2021. Submersible traveling screens (STSs) for all operating units were installed between March 30 and March 31. The Juvenile Fish Facility (JFF) was watered up at on March 24 and fish condition monitoring began on April 1 and continued through July 1. The JFF was dewatered on November 17.

Total smolts sampled in the 2021 season was 3,249. This seasons sample by species group included: 1050 clipped and 210 unclipped yearling Chinook *Oncorhynchus tschawytscha*, 875 clipped and 166 unclipped steelhead *O. mykiss*, 524 unclipped and 369 clipped subyearling Chinook salmon, 29 clipped/unclipped coho salmon *O. kisutch*, and 7 clipped and 19 unclipped sockeye/kokanee *O. nerka*.

The removable spillway weir (RSW) was operated for juvenile fish passage from April 3 to July 9. The RSW was closed before the end of the summer spill season on July 9 due to tailwater temperatures and low river flows. The RSW was periodically opened from October 1 to November 15 for the downstream passage of adult steelhead. During that period, the RSW was operated from approximately 0500 hours to 0900 hours on Sundays, Wednesdays, and Fridays.

Facility Introduction and Description

The juvenile fish passage facility at Ice Harbor Dam consists of standard-length submersible traveling screens, vertical barrier screens, 36 12-inch diameter orifices, a collection channel and dewatering structure, fish sampling facilities and a transportation flume to the tailrace downstream from the dam. The juvenile fish collection channel is operated with approximately 300 cubic feet per second (cfs) flow (forebay head-dependent), which is the design operating flow produced by 20 of the juvenile fish passage orifices open. All but 30 cfs of the flow is removed at the primary dewatering structure and utilized as adult fish attraction water. The remaining 30 cfs flow and fish are routed through a transport pipe and flume to the fish sampling facility or directly to the tailwater.

The adult fish passage facilities at Ice Harbor dam are comprised of separate north and south shore systems. The north shore facilities include a fish ladder with an adult counting station, an adult fish collection channel, and a pumped auxiliary water supply system. The collection system includes two downstream entrances near the navigation lock wall at the base of the dame and one side entrance, which is bulkheaded off from the spillway basin. The downstream entrance nearest the navigation lock wall is normally open for fish passage. Three electric pumps supply the auxiliary water for fish attraction flow. Two of the three pumps operate continuously during normal operation. The third pump serves as a backup in the case of a pump failure.

The south shore facilities are comprised of a fish ladder with an adult counting station, two south shore entrances, a powerhouse collection system, and a pumped auxiliary water supply system. The powerhouse collection system includes two downstream entrances and on side entrance, which is bulkheaded off from the spillway basin at the north end of the powerhouse, twelve floating orifices, and a common fish transportation channel. The fishway entrances used during normal operation include: one south shore entrance nearest the powerhouse, one downstream north powerhouse entrance, and four floating orifice gates. Eight electric pumps are available to supply the auxiliary water for fish attraction, of which five to eight pumps are used during normal operation.

Facility Modification, Maintenance, and Improvements

During winter maintenance, mechanics replaced damaged rollers on NEW-1 weir, and electricians installed new above-ground conduit and wiring at the north fish entrance deck for the weir control system. NEW-1 is now electronically operable as the backup fish entrance for the north ladder.

The broken air bubbler piping at the south fish ladder exit was replaced during the winter maintenance outage. An air hose was temporarily set up during the 2020 season to help keep debris away from the exit.

Finally, the deteriorated fish jump-netting near the south fish ladder upper diffuser was replaced with new netting.

River Conditions

During the 2021 season, the average daily powerhouse flow and spill was less than the 2016-2020 average during all months (Table 1).

The highest daily flow for the season was 91.5 kilo cubic feet per second (kcfs) on June 5. The lowest daily flow for the season occurred October 21 with a flow of 12.1 kcfs. The average flow for the season was 41.1 kcfs, (Figure 1).

The highest daily spill of 66.76 kcfs occurred on May 19. The lowest spill was for the season occurred on October 18 at 0.06 kcfs. The average spill for the season was 3.3 kcfs.

Table 1. Comparison of average flow (kcfs) and Spill (kcfs) at Ice Harbor Dam, 2016-2021 and the 5-year average.

Flow (kcfs)							
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2016-2020 Avg**	**2021**
April	90.7	142.0	98.6	126.0	57.0	102.9	52.1
May	90.5	142.3	139.2	122.5	107.8	120.4	71.3
June	54.7	134.2	85.9	90.5	100.4	93.1	54.3
July	33.1	53.7	40.1	38.8	50.6	43.3	26.9
August	25.4	31.3	30.1	28.3	30.1	29.0	23.1
September	18.7	25.6	22.1	24.6	23.0	22.8	18.6
Spill (kcfs)							
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2016-2020 Avg**	**2021**
April	55.0	92.5	78.6	83.6	34.4	68.8	30.7
May	50.6	93.3	93.3	85.5	78.6	80.2	47.8
June	29.0	85.1	60.2	53.7	74.2	60.4	30.9
July	19.1	33.8	25.1	11.7	16.5	21.2	8.1
August	14.6	21.4	20.2	8.7	9.0	14.8	8.0
September	0.4	1.4	0.8	0.0	0.3	0.6	0.0

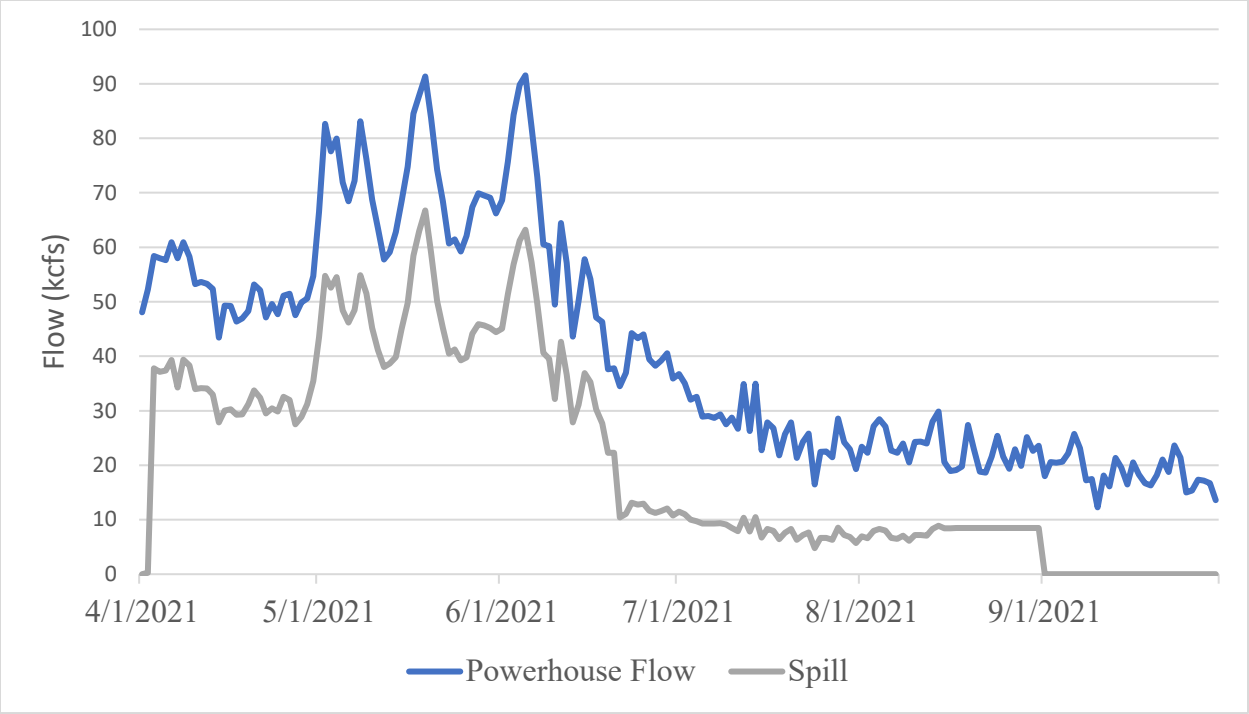

Figure 1. Comparison of daily powerhouse flow and spill at Ice Harbor Dam, 2021.

River Temperature

The highest average river temperature in 2021 was 72.7°F on August 19. The lowest river temperature occurred during the week of February 19 to 25 and was recorded at 38°F degrees. The temperature for April and September was lower in 2021 than for the 2016-2020 Avg, however there were less than a1-degree difference between April and September of 2016-2020 and April and September of 2021. The average temperatures for 2021 were higher in May, June, July, and August than the average 5-year temperature, (Table 2).

Table 2. Average monthly river temperatures, 2016-2021 at Ice Harbor Dam and 5-year average.

Temperature (F◦)							
Month	**2016**	**2017**	**2018**	**2019**	**2020**	**2016-2020 Avg**	**2021**
April	50.5	48.4	48.4	48.6	48.3	48.9	48.5
May	55.6	53.5	54.5	55.3	53.2	54.4	55.5
June	62.0	58.7	61.1	60.9	58.0	60.1	61.6
July	68.0	68.4	67.4	67.4	65.4	67.3	71.3
August	70.4	70.8	70.1	70.1	69.7	70.2	71.3
Sept.	66.9	67.6	66.7	68.5	66.9	67.3	67.2

Juvenile Fish Facility Operations and Maintenance

Sampling

Sampling is defined as diverting and segregating groups of fish in a consistent fashion so data collected from those segregated groups will accurately represent all fish collected. Fish were sampled at Ice Harbor to monitor fish condition. This type of sampling is called sampling for condition. Normal operation of the facilities is to bypass all collected fish directly to the river, except when routine sampling is conducted for monitoring fish condition. The goal of a sampling event is to collect 100 fish of the predominant species within a four-hour period. Fish are visually counted as they come into the fish separator structure. During the beginning and the latter part of the season, migrating fish numbers can be low, so the target number of fish may not be collected during the four-hour period. Fish condition sampling began on April 1 and occurred on Mondays and Thursdays each week. The last sample of the season occurred on July 1, after the water temperatures increased to over 70°F, ending the sampling season.

A total of 3,249 juvenile salmonids were sampled during the 2021 season (Table 3). This is a decrease from 2020 during which 3,518 were sampled (Table 4).

Table 3. Number of juvenile salmonids sampled per day at Ice Harbor Dam, 2021.

Date	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Daily Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
1-Apr	74	23	0	0	0	1	0	0	0	98
5-Apr	86	9	0	0	1	1	0	0	0	97
8-Apr	103	3	0	0	5	0	0	0	0	111
12-Apr	66	6	0	0	42	3	0	0	0	117
15-Apr	53	5	0	0	61	12	0	0	0	131
19-Apr	80	7	0	0	51	8	0	0	0	146
22-Apr	81	11	0	0	70	12	0	0	0	174
26-Apr	32	18	0	0	74	20	0	0	0	144
29-Apr	19	15	0	0	90	11	0	0	0	135
3-May	65	28	0	0	65	8	0	4	0	170
6-May	52	11	0	0	80	10	0	3	0	156
10-May	39	8	0	0	80	11	0	2	1	141
13-May	67	7	0	0	77	14	0	0	0	165
17-May	90	20	0	1	22	4	5	3	1	146
20-May	91	8	1	2	44	9	0	2	1	158
24-May	32	24	11	24	40	13	1	2	3	150
27-May	7	2	26	33	9	10	0	0	3	90
31-May	6	1	6	14	5	3	0	0	1	36
3-Jun	5	2	11	21	8	0	0	2	4	53
7-Jun	0	1	46	61	20	5	1	1	2	137
10-Jun	0	0	32	59	6	2	0	0	2	101
14-Jun	0	0	31	49	5	2	0	0	2	89
17-Jun	0	0	34	65	2	0	0	0	0	101
21-Jun	2	0	39	43	12	6	0	0	3	105
24-Jun	0	0	53	39	4	1	0	0	2	99
28-Jun	0	1	47	50	2	0	0	0	2	102
1-Jul	0	0	32	63	0	0	0	0	2	97
Totals	1050	210	369	524	875	166	7	19	29	3,249
% Totals	32.32%	6.46%	11.36%	16.13%	26.93%	5.11%	0.22%	0.58%	0.89%	***

Table 4. Number of juvenile salmonids sampled at Ice Harbor Dam, 2017-2021

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
2017	747	489	386	624	845	335	13	12	34	3,485
2018	619	333	363	545	948	264	31	18	38	3,159
2019	748	331	552	680	1082	270	71	5	32	3,771
2020	1025	279	356	598	1022	229	7	0	2	3,518
2021	1050	210	369	524	875	166	7	19	29	3249

Within each species group the number and percent sampled of those collected in that group was: 1050 clipped yearling Chinook salmon (32.3%), 875 clipped steelhead (26.9%), 524 unclipped subyearling Chinook salmon (16.1%), 369 clipped subyearling Chinook salmon (11.4%), 210 unclipped yearling Chinook salmon (6.5%), 166 unclipped steelhead (5.1%), 29

clipped/unclipped coho salmon (.9%), 19 unclipped sockeye (.6%), and 7 clipped sockeye/kokanee salmon (.2%), (Table 4) and (Table 5).

Table 5.Annual percentage sampled of each juvenile salmonid species at Ice Harbor Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip
2017	21.4%	14.0%	11.1%	17.9%	24.2%	9.6%	0.4%	0.3%	1.0%
2018	19.6%	10.5%	11.5%	17.3%	30.0%	8.4%	1.0%	0.6%	1.2%
2019	19.8%	8.8%	14.6%	18.0%	28.7%	7.2%	1.9%	0.1%	0.8%
2020	29.1%	7.9%	10.1%	17.0%	29.1%	6.5%	0.2%	0.0%	0.1%
2021	32.3%	6.5%	11.4%	16.1%	26.9%	5.1%	0.2%	0.6%	0.9%

In 2021 the peak daily collection total and date for each species group were: 103 clipped yearling Chinook salmon (April 8), 90 clipped steelhead (April 29), 65 unclipped subyearling Chinook salmon (June 17), 53 clipped subyearling Chinook salmon(June 24), 28 unclipped yearling Chinook salmon(May 3), 20 unclipped steelhead (April 26), 5 clipped sockeye/kokanee salmon(May 17), 4 unclipped sockeye/kokanee salmon(May 3), and 4 coho (June 3) with a daily maximum collection of 174 fish occurring on April 22, (Table 6).

Table 6. Annual peak collection dates at Ice Harbor Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip
2017	15-May 67	6-April 51	12-June 67	13-Jul 98	27-Apr 89	25-May 56	25-May 4	-- --	22-May 13
2018	7-May 65	9-Apr 61	31-May 51	1-Jun 76	10-May 90	24-May 39	24-May 15	21-May 7	24-May 10
2019	29-Apr 81	4-Apr 46	8-Jul 58	3-Jun 73	22-Apr 137	22-Apr 26	23-May 39	27-May 2	27-May 13
2020	11-May 91	30-Apr 25	22-Jun 55	2-Jul 69	23-Apr 88	28-May 26	18-May 3	-- --	21-May 2
2021	8-Apr 103	3-May 28	24-Jun 53	17-Jun 65	29-Apr 90	26-Apr 20	17-May 5	3-May 4	3-Jun 4

Descaling

The descaling rate for all fish sampled in 2021 was 2.5%, (Table 8). The most fish found with descaling occurred on May 10 totaling 9, (Table 7). All other days during sampling the number of fish found with descaling was less than 9. The majority of fish found with descaling were clipped/unclipped steelhead.

Table 7. Number of salmonids sampled with descaling at Ice Harbor, 2021.

Date	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
1-Apr	0	0	---	---	---	0	---	---	---	0
5-Apr	0	0	---	---	0	0	---	---	---	0
8-Apr	0	0	---	---	0	---	---	---	---	0
12-Apr	0	0	---	---	2	0	---	---	---	2
15-Apr	0	0	---	---	3	2	---	---	---	5
19-Apr	0	0	---	---	1	0	---	---	---	1
22-Apr	2	0	---	---	2	0	---	---	---	4
26-Apr	1	0	---	---	1	1	---	---	---	3
29-Apr	0	0	---	---	0	1	0	0	0	1
3-May	4	0	---	---	0	0	---	0	---	4
6-May	2	1	---	---	3	0	---	0	---	6
10-May	1	0	---	---	6	2	---	0	0	9
13-May	3	0	---	---	3	1	---	---	---	7
17-May	8	0	---	0	0	0	0	0	0	8
20-May	2	0	0	0	4	0	---	0	0	6
24-May	5	0	0	0	2	1	0	0	---	8
27-May	0	1	1	0	0	0	---	---	0	2
31-May	0	0	0	0	0	0	---	---	0	0
3-Jun	0	0	0	0	0	---	---	0	0	0
7-Jun	---	0	0	1	2	0	0	0	0	3
10-Jun	---	---	0	0	0	0	---	---	0	0
14-Jun	---	---	1	2	0	0	---	---	0	3
17-Jun	---	---	0	2	0	---	---	---	---	2
21-Jun	0	---	0	3	1	0	---	---	0	4
24-Jun	---	---	0	0	0	0	---	---	0	0
28-Jun	---	0	1	1	0	---	---	---	0	2
1-Jul	---	---	0	1	---	---	---	---	1	2
Totals	28	2	3	10	30	8	0	0	1	82

The annual descaling rate by species group was clipped yearling Chinook salmon(2.7%), unclipped yearling Chinook salmon (1.0%), clipped subyearling Chinook salmon(.8%), unclipped subyearling Chinook salmon (1.9%), clipped steelhead (3.4%), unclipped steelhead (4.8%), clipped and unclipped sockeye/kokanee (0%), and coho salmon (3.4%), (Table 8).

Table 8. Percent of descaled salmonids at Ice Harbor Dam, 2021.

Date	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
1-Apr	0.0%	0.0%	---	---	---	0.0%	---	---	---	0.0%
5-Apr	0.0%	0.0%	---	---	0.0%	0.0%	---	---	---	0.0%
8-Apr	0.0%	0.0%	---	---	0.0%	---	---	---	---	0.0%
12-Apr	0.0%	0.0%	---	---	4.8%	0.0%	---	---	---	1.7%
15-Apr	0.0%	0.0%	---	---	4.9%	16.7%	---	---	---	3.8%
19-Apr	0.0%	0.0%	---	---	2.0%	0.0%	---	---	---	0.7%
22-Apr	2.5%	0.0%	---	---	2.9%	0.0%	---	---	---	2.3%
26-Apr	3.1%	0.0%	---	---	1.4%	5.0%	---	---	---	2.1%
29-Apr	0.0%	0.0%	---	---	0.0%	9.1%	---	---	---	0.7%
3-May	6.2%	0.0%	---	---	0.0%	0.0%	---	0.0%	---	2.4%
6-May	3.8%	9.1%	---	---	3.8%	0.0%	---	0.0%	---	3.8%
10-May	2.6%	0.0%	---	---	7.5%	18.2%	---	0.0%	0.0%	6.7%
13-May	4.6%	0.0%	---	---	3.9%	7.1%	---	---	---	4.3%
17-May	8.9%	0.0%	---	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.5%
20-May	2.2%	0.0%	0.0%	0.0%	9.1%	0.0%		0.0%	0.0%	3.8%
24-May	15.6%	0.0%	0.0%	0.0%	5.0%	7.7%	0.0%	0.0%	---	5.4%
27-May	0.0%	50.0%	3.8%	0.0%	0.0%	0.0%	---	---	0.0%	2.2%
31-May	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	---	---	0.0%	0.0%
3-Jun	0.0%	0.0%	0.0%	0.0%	0.0%	---	---	0.0%	0.0%	0.0%
7-Jun	---	0.0%	0.0%	1.7%	10.0%	0.0%	0.0%	0.0%	0.0%	2.2%
10-Jun	---	---	0.0%	0.0%	0.0%	0.0%	---	---	0.0%	0.0%
14-Jun	---	---	3.2%	4.2%	0.0%	0.0%	---	---	0.0%	3.4%
17-Jun	---	---	0.0%	3.1%	0.0%	---	---	---		2.0%
21-Jun	0.0%	---	0.0%	7.0%	8.3%	0.0%	---	---	0.0%	3.8%
24-Jun	---	---	0.0%	0.0%	0.0%	0.0%	---	---	0.0%	0.0%
28-Jun	---	0.0%	2.1%	2.0%	0.0%	---	---	---	0.0%	2.0%
1-Jul	---	---	0.0%	1.6%	---	---	---	---	50.0%	2.1%
Total Examined	1,050	210	369	524	875	166	7	19	29	3,249
% Descaled	2.7%	1.0%	0.8%	1.9%	3.4%	4.8%	0.0%	0.0%	3.4%	2.5%

-- No fish of this species sampled

In 2021 the descaling of 2.7% for all fish examined was lower than the rates in 2017-2020. Steelhead had the highest amount of descaling observed in 2017, 2019, and 2021. Sockeye/kokanee had the highest amount in 2018 and 2020, (Table 9).

Table 9. Annual descaling rates in percent for fish sampled at Ice Harbor Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
2017	5.9%	2.5%	0.5%	0.5%	6.0%	5.7%	0.0%	0.0%	5.9%	3.8%
2018	4.4%	6.0%	2.5%	4.0%	10.7%	12.5%	16.1%	16.7%	5.3%	7.0%
2019	3.7%	2.4%	3.6%	2.5%	5.5%	8.9%	1.4%	0.0%	3.1%	4.2%
2020	1.8%	1.8%	0.3%	1.0%	4.8%	6.6%	28.6%	--	0.0%	2.7%
2021	2.7%	1.0%	0.8%	1.9%	3.4%	4.8%	0.0%	0.0%	3.4%	2.5%

-- No fish of this species sampled

Mortality

There were a total of 20 juvenile facility mortalities for all salmonids for 2021, (Table 10). Fish that are dead prior to coming into the lab are not examined for condition but are included in the sample number.

Table 10. Total sample mortality at Ice Harbor Dam, 2021.

	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
1-Apr	0	0	0	0	0	0	0	0	0	0
5-Apr	1	0	0	0	0	0	0	0	0	1
8-Apr	0	0	0	0	0	0	0	0	0	0
12-Apr	0	0	0	0	0	0	0	0	0	0
15-Apr	0	0	0	0	0	0	0	0	0	0
19-Apr	0	0	0	0	0	0	0	0	0	0
22-Apr	1	0	0	0	0	0	0	0	0	1
26-Apr	0	0	0	0	0	0	0	0	0	0
29-Apr	0	0	0	0	0	0	0	0	0	0
3-May	2	0	0	0	0	0	0	0	0	2
6-May	0	0	0	0	0	0	0	0	0	0
10-May	5	1	0	0	0	0	0	0	0	6
13-May	5	0	0	0	0	0	0	0	0	5
17-May	0	0	0	0	0	0	0	0	0	0
20-May	0	0	0	0	0	0	0	0	0	0
24-May	0	1	0	0	0	0	0	0	0	1
27-May	0	0	0	0	0	0	0	0	0	0
31-May	0	0	0	1	1	0	0	0	0	2
3-Jun	0	0	0	0	0	0	0	0	0	0
7-Jun	0	0	0	0	0	0	0	0	0	0
10-Jun	0	0	0	0	0	0	0	0	0	0
14-Jun	0	0	0	0	0	0	0	0	0	0
17-Jun	0	0	0	0	0	0	0	0	0	0
21-Jun	0	0	0	0	0	0	0	0	0	0
24-Jun	0	0	0	0	0	0	0	0	0	0
28-Jun	0	0	0	1	0	0	0	0	0	1
1-Jul	0	0	0	1	0	0	0	0	0	1
Totals	14	2	0	3	1	0	0	0	0	20

Annual mortality for all groups combined was .6% in 2021 and totaled 20 fish. Within each species group, the number of mortalities and percent of those collected in that group was: 14 clipped yearling Chinook salmon(1.3%), 2 unclipped yearling Chinook salmon(1.0%), 0 clipped subyearling Chinook salmon, 3 unclipped subyearling Chinook salmon(.6%), and1 clipped steelhead (.1%). There were no unclipped steelhead, clipped and unclipped sockeye/kokanee salmon, or coho salmon mortalities in 2021, (Table 11).

Table 11. Annual mortality in percent at Ice Harbor Dam, 2017-2021.

Year	Yearling Chinook		Subyearling Chinook		Steelhead		Sockeye/Kokanee		Coho	Total
	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clipped	Unclip	Clip/Unclip	
2017	0.4%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	8.3%	0.0%	0.2%
2018	0.3%	0.9%	0.3%	0.0%	0.0%	0.4%	3.2%	0.0%	0.0%	0.3%
2019	0.0%	0.0%	0.0%	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
2020	0.6%	0.4%	0.0%	0.5%	0.3%	0.0%	0.0%	--	0.0%	0.4%
2021	1.3%	1.0%	0.0%	0.6%	0.1%	0.0%	0.0%	0.0%	0.0%	0.6%

-- No fish of this species sampled

Maladies

Maladies are recorded for each sample and sent to the Fish Passage Center (FPC) after the sample is completed. For the 2021 season, maladies found within all species groups included body injury, head injury, eye injury, eye hemorrhage, popeye, operculum, fin injury, fungus, fin hemorrhage, fin deformity, parasites, Columnaris, and fin discoloration. The highest maladies from all species groups combined were eye hemorrhage, operculum, fungus, body injury and fin injury. The majority of the maladies came from clipped yearling Chinook and clipped steelhead. The highest maladies from clipped yearling Chinook included eye hemorrhage and fin injury. The highest maladies from clipped steelhead were operculum fungus, fin injury and body injury. No exact counts are listed within this report for maladies, only general observation of the data provided from the samples was used.

Incidental Species

Non-target fish species were counted and then released at the separator or with the sample fish. The most common incidental species group for 2021 was Siberian prawn, *Exopalaemon modestus* (53). The other species were juvenile Pacific lamprey ammocoete *Lampetra tridentatus* (1), adult American shad *Alosa sapidissima* and largemouth bass, *Micropterus salmoides* (1), (Table 12).

Table 12. Incidental species collected during sampling at Ice Harbor Dam, 2021.

Common Name	Scientific Name	Sample
Siberian Prawn	*Exopalaemon modestus*	53
Largemouth & Smallmouth Bass	*Micropterus dolomieu/salmoides*	2
Crappie	*Lepomis spp.*	1
Pacific Lamprey (Juvenile)	*Lampetra tridentatus*	1
Others	50	
Totals	107	

Siberian prawns were collected in the sample at the juvenile fish facility and were humanely euthanized by fish condition personnel, frozen and properly disposed of in a landfill.

Adult Salmonid Fallbacks

A total of 4 adult salmonids were released from the separator in 2021. The salmonids consisted of 2 clipped and 2 unclipped steelhead. All the salmonids were classified in good condition except for a clipped steelhead on April 29. This steelhead was classified in poor condition, (Table 13).

Table 13. Daily totals of adult salmonids released from the separator and condition at Ice Harbor Dam, 2021.

Date	Chinook	Chinook Jack	Steelhead Clipped	Steelhead Unclip	Sockeye	Coho	Condition
1-Apr	0	0	0	1	0	0	Good
29-Apr	0	0	1	0	0	0	Poor
24-May	0	0	1	0	0	0	Good
17-Jun	0	0	0	1	0	0	Good
Total	0	0	2	2	0	0	

The annual totals of adults released from the separator for 2021 was less than the previous years, except in 2020, (Table 14). In 2020 only 1 Chinook salmon was released. Steelhead were the only salmonid found in and released in the separator for 2021.

Table 14. Annual totals of adult salmonids released from the separator at Ice Harbor Dam, 2017-2021.

Year	Chinook	Chinook Jack	Steelhead Clipped	Steelhead Unclip	Sockeye	Coho	Total
2017	6	2	3	1	0	0	12
2018	4	0	1	0	0	0	5
2019	1	0	3	2	0	0	6
2020	1	0	0	0	0	0	1
2021	0	0	2	2	0	0	4

Facility Operations and Maintenance

Turbine Operations

Efforts were made to operate all turbine units within 1% of peak efficiency from April 1 to October 31, inclusive. Deviations were infrequent and brief. The project ran outside the constraint at the request of the Bonneville Power Administration (BPA). Unit priority was in effect from March 1 to November 30. Units were taken out of service (OOS) for various reasons throughout the year. (Table 15) provides a summary of unit outages and causes.

Table 15. Unit outages and return to service dates for Ice Harbor Dam, 2021.

Date out of service (OOS)	Unit	Outage Description
3 May 2019	Unit 3	Turbine runner replacement and stator rewind
28-29 March	Unit 5	86GT delayed shutdown lockout-system was reset
30-31 March	All Units, except 3	Push debris down trash rack and install STSs
7April	Unit 2	Index testing
11-12 May	Units 1,2,6	Rake units trash racks
18-27 May	Unit 6	Replaced faulty governor oil check valve
24 May	Unit 2	Failed motor on 2A STS
29 May-1 June	Unit 6	6B STS tripping breaker-replace STS with spare
14-15 June	Unit 6	6B STS tripping breaker-replace STS with spare
23 June	Unit 5	Pre-maintenance testing
6-29 July	Unit 5	Annual Maintenance
18 July-19 August	Unit 6	Annual Maintenance and new oil
31 July-3 August	Unit 1	Tripped off due to wicket gate response problem
16 August	Unit 1	Drain oil from thrust bearing
16 August-10 September	Unit 4	Annual Maintenance and new oil
5-7 September	Unit 5	Governor tripped off
7-10 September	Unit 2	Thrust bearing pump losing pressure-replaced oil
29 September	Unit 2	GDACS software problem
5 October	Unit 5	Replaced burned out brake solenoid
14 October	Unit 2	Water in turbine bearing sump-replaced leaky oil cooler
25-28 October	Unit 1	Intake gate downpull testing, STS Inspection
25 October	Unit 2	Power loss to Turbine bearing oil pump from Line 2 tripping
25 October	All Units, except 3	Hub tap, STS Inspection
1 November-2 December	Unit 2	Annual Maintenance
6 December	Unit 1	Annual Maintenance, exciter relay upgrade

Unit 2 was noted to be operating a few megawatts (MW) above the 1% operating efficiency range on March 31. Units 4 and 6 were operating a few MW below the operating efficiency range on April 1. Unit 2 was operated under various loads, including below the 1% operating efficiency range on April 7 at 0722, for index testing. Units 4 and 6 were noted to be operating a few MW above the 1% operating efficiency range on the May 4 fishway inspection. Unit 4 was observed to be operating a few MW above the 1% operating efficiency range on the May 26 fishway inspection. Units 5 and 6 were noted to be operating a few MW below the 1% operating efficiency range on May 27. Units 2 and 6 were noted to be operating a few MW below the 1% operating efficiency range on the June 24 fishway inspection.

Removable Spillway Weir

The RSW was be operated from 0500 hours to 0900 hours on Sundays, Wednesdays, and Fridays, from March 1 to March 31 and from 1 October to 15 November, for the downstream passage of adult steelhead. Spring spill for fish passage started on April 3 at 0100 hours.

Spill gate # 10 closed by itself at 1230 hours on July 1 due to a keyway in the gearbox that came loose. A new keyway was installed and spill gate #10 was opened back up at 1435 hours on July 1. The total required amount of spill was not affected by the closure of bay #10 and was made up by opening the next spillbay.

The RSW was closed on July 9, before the end of the summer spill season, to reduce tailrace water temperatures and remain closed because of low river flows. Spring spill for fish passage ended on August 14. Summer spill began on August 15 and ended on August 31 at 2338 hours.

Debris and Trash Racks

In 2021, debris accumulation began early in the season. Following an inspection, it was deemed unsafe to use the rake for lifting, therefore, debris was pushed down onto the bottom of the trash rack for units 2 and units 4-6 on March 28 and 29 prior to installing STSs. On May 10, the Project Biologist requested from project maintenance that the debris on the unit trash racks again be pushed down with the intake trash rake to see if that would reduce the prevalence of fish injuries and descaling. Therefore, on May 11 and 12, 35-tons of debris was raked off units 1, 2, and 6. The majority of debris was removed from units 1 and 2.

Gatewells

Gatewell slots were checked for debris three times a week during ladder inspections. Small amounts of woody material were noted in gatewell slots, but did not approach the 50% coverage criteria point for mandatory cleaning. Slots were dipped for debris removal prior to installing STSs.

An oil sheen was observed in 6A and 6C head gate and gatewell slots on May 24. Approximately 1 cup of hydraulic oil is estimated to have leaked past the head gate cylinder seals after unit 6 head gates were closed on May 18. Oil absorbent socks were deployed on May 24 and the appropriate agencies were notified of the oil spill.

An oil sheen was report in gatewell 6C on July 20. Only a teaspoon of oil residue was reported, and absorbent booms were deployed to soak up the oil residue. A light oil sheen was observed in gatewell 6A on July 27. The sheen is suspected to be hydraulic oil residue from the head gate cylinder. An oil absorbent boom was deployed in the head gate slot and the appropriate state and federal agencies were notified of the oil spill.

On August 31 at 0800 hrs. a slight oil sheen was seen in Gate well slot 6C. It was reported to operations, who then reported it to the proper authorities. An oil boom was deployed into the gate well shortly after it was reported.

Submersible Traveling Screens

STSs were installed on March 30 for unit 1 and units 2, 4,5, and 6 were installed on March 31. Unit 3 was not installed during 2021 because the unit was OOS for runner replacement and stator rewind.

STSs were switched to continuous-run mode on April 1 due to the presence of small juvenile sockeye salmon in the fish sample. The sockeye salmon were later classified as kokanee and the STSs were switched back to cycle-run on April 5. STSs were switched to continuous-run mode on May 4 due to the presence of subyearling Chinook salmon and sockeye salmon in the May 3 sample with an average fork length of less than 120 mm. During the week of July 16-22, the STSs were returned to cycle mode, since juvenile salmonids were measured with a fork length greater than 120 mm.

STS units 1, 2, and 4-6 were inspected on May 18-19 and June 22-23. Inspections were conducted on July 19-21 for units 1, 2, and 4-6. units 1, 2, 4 and 6. STSs were inspected August 16-18. The STSs for units 1, 2, and 4-6 were inspected on September 20-22. Units 1, 2, and 4-6 STSs were inspected October 25-28. Inspections were done with an underwater camera. There were no significant problems found during any inspections listed above, except for the one listed below.

During 2021, two issues were discovered concerning STSs. On May 24, electricians determined that the STS in slot 2A had a failed motor. The bad STS was removed and replaced with a spare STS on May 24. A tear was found on STS for 2B on July 21. The STS for 2B was swapped out with a spare STS and unit 2 was returned service the same day.
STSs were raised for the year on November 15-17 for winter maintenance. STSs were pulled a month early to accommodate the contract to upgrade the intake crane and to accomplish the modification to the lifting beam for the unit trash rake.

Vertical Barrier Screens

Project personnel inspected vertical barrier screens (VBSs) while conducting STS inspections. All VBSs were inspected except for unit 3 which was out of service. Unit 1 VBSs were inspected on April 21. A hole that is estimated to be 1.5” x 2.5” was observed on the VBS in slot 1A. Unit 2 VBSs were inspected on May 18-19. Unit 6 VBSs were inspected on June 22-23. Inspections were conducted on July 19-21 for unit 4 VBSs. Unit 5 VBSs were inspected on August 16-18. No problems were found during any inspections except for the one listed below. On April 26 the hole found during the April 21 inspection was patched along with six smaller holes found on the screen.

Juvenile Collection Channel (JCC) Orifices

The JCC channel was watered up on March 24. The collection channel was typically operated with 20 orifices open. At least one orifice was open in each gatewell slot. Some exceptions to

this were if orifices were closed in individual gatewells for brief periods during the season to accommodate routine maintenance and repair, such as backflushing, STS inspections or STS repair. On November 17, orifices were closed, and the juvenile fish channel was dewatered for winter maintenance. Issues with the orifices were found throughout the season and listed in (Table 16).

Orifices were cycled and backflushed starting March 24 once per day through March 31. On March 25 some of the orifice filters were found to be dirty and were replaced with new filters to improve the operation of fully opening and closing the orifices.

Starting April 1, orifices were backflushed three times a day through July 31. There were no debris obstructions observed at the orifices, as indicated by reduced flow through the orifices. There were a few larger sticks that came into the separator on April 1, but not when the orifices were being backflushed.

The actuator for the ladder water regulating weirs was found to be without power on April 1. Electricians determined that the actuator is failing and was tripping the disconnect. In the meantime, the water level in the collection channel is being monitored and the actuator was operated manually to adjust the weirs. On April 7 a spare actuator was installed. Unfortunately, the replacement actuator could not be operated automatically because it did not have an analog controller input. Therefore, the water level in the collection channel was visually monitored three times per day and the actuator was operated electronically in "local" control to adjust the weirs as needed. An analog controller input was installed between April 23 and 26 but needs to be programmed. Until then the collection level was monitored as described above.

Between July 30th and August 5th, the monitoring of collection channel water level was dropped to once a day.

During the plant power outage on October 25, the biologist noticed that there was only about 6" of water in the main bypass flume. Fisheries staff quickly went up to the juvenile fish collection channel and saw that almost all the orifices were shut. The orifices had shut automatically when the power went out. The maintenance worker opened the flush valve to prevent the flume from drying out. Most of the orifices have an electric switch to operate, so they could not be opened back up while the power was out. When the power was restored after about 30 minutes, the orifices opened automatically. The reason for the orifices shutting automatically with the power outage is under investigation.

The annual video inspection of the interior bypass pipe with the pipe crawler occurred on November 30.

Table 16. Orifice lights replaced at Ice Harbor Dam, 2021.

Orifice	Date Found	Date Replaced	Actions Taken
1CN	24-Mar	25-Mar	Light replaced
4CN	24-Mar	25-Mar	Light replaced
2BN	2-May	3-May	Orifice 2BS was used until 2BN's light was replaced
4BN	29-May	2-Jun	Orifice 4BS was used until the light ballast was replaced
2BN	28-Jun	29-Jun	Orifice 2BS was used until 2BN's light was replaced
3BN	3-Aug	4-Aug	Orifice 3BS was used until 3BN's light was replaced
6CN	24-Aug	24-Aug	Replaced same day
5CN	Between 17-19-Sep	20-Sep	Light replaced
3CN	13-Oct	18-Oct	Orifice 3CS was used until 3CN's light was replaced
1CN	25-Oct	26-Oct	Orifice 1CS was used until 1CN's light was replaced
1BN	26-Oct	27-Oct	Orifice 1BS was used until 1BN's light was replaced
1CN	1-Nov	2-Nov	Orifice 1CS was used until 1CN's light was replaced
1BN	Between 5-7 Nov	8-Nov	Orifice 1BS was used until 1BN's light was replaced
5BN	12-Nov	15-Nov	Orifice 5BS was used until 5BN's light was replaced

Primary Dewatering Structure (PDS)

The juvenile fish collection channel, including the PDS was opened on March 24 and was closed for winter maintenance on November 18.

The compressed air screen cleaner functioned well throughout the 2021 season. However, problems were experienced with the mechanical screen cleaner.

On August 11, the mechanical screen cleaner was observed to be parked at the upstream end of the primary dewatering structure with the brush part way in the water. The brush lift cable had come off the lower pulley. The screen cleaner was shut off to prevent damage to the cable. Mechanics got the cable back on the pulley and the screen cleaner was returned to service later the same day. Electricians later adjusted the uptake on the pulley to reduce the slack in the cable as the screen cleaner travels downstream. This adjustment should prevent the cable from slipping off the pulley. On August 30 the screen cleaner brush lift cable frayed, it was put out of service and reported to operations. On September 1 it was repaired and returned in service. The mechanical screen cleaner was taken out of service on October 4 due to the drive cable coming off the sheaves and the cable starting to fray. The drive pulley had also become deeply grooved from the friction of the cable against the pulley. The water regulating weirs had to be lowered during the week to maintain the proper level as debris accumulated on the inclined floor screen during the outage. The drive pully was removed, and a new pully was machined and installed. The new pulley should reduce the binding of the drive cable and keep the cable on the sheaves. The screen cleaner was returned to service on October 13. The mechanical screen cleaner was found to be inoperable on October 20 due to the bracket for the drive cable sheaves breaking off and the cable wrapping over itself on the drive pulley. The bracket was welded back onto the screen cleaner and the frayed cable was replaced. The screen cleaner was returned to service on October 26. The water regulating weirs were lowered as necessary to maintain the proper water

level as debris accumulated on the inclined floor screen during the outage. The mechanical screen cleaner was found on November 9 with the bracket for the drive cable sheaves broken off once again. The bracket was bolted back onto the screen cleaner the same day. The screen cleaner was operated in "manual mode" four times per day for the remainder of the season.

Juvenile Fish Facility

A bright light was recently installed over the sample holding tank anesthetizing chamber to improve visibility when crowding fish into the chamber.

The raw water supply lines at the fish facility were watered up on March 24. The raw water supply lines in the Fish Facility were drained and winterized on October 6.

Fish Salvage

The juvenile fish channel was dewatered on November 18. The rescued fish were composed of 21 clipped adult steelhead, 8 unclipped adult steelhead, 4 unclipped juvenile steelhead, 10 adult Pacific lamprey, 5 channel catfish, and 26 adult shad. Fish were released in good condition at the Levey Park boat ramp.

Cooling Water Strainers

Turbine unit cooling water strainers were examined for biologic content at least once per month from January through July and from November to December except for unit 3 which was OOS during 2021. The strainers were also cleaned when accumulation of debris and fish resulted in a high-pressure differential.

The majority of species found in the strainers were: American shad totaling 26,671, 418 Pacific lamprey, 1 clipped Chinook salmon and 44 Siberian prawns. The percentage of each of these species are as follows: American shad at 98%, Pacific lamprey at 1.5%, and Siberian prawn and salmonids at less than 1%.

The total number of Pacific lamprey removed, dead or alive, from the water cooler strainers for the last 5 years are in Table 17. Less Pacific lamprey were found in 2021 than in 2020. Probability of individuals being alive at the time of strainer cleaning was likely more related to time of entry rather than which unit's strainer it was found in.

Table 17. Pacific lamprey removed from turbine cooling water strainers from Ice Harbor Dam, 2017-2021.

Pacific lamprey (Juvenile)			
Year	Live	Dead	Total
2017	6	470	476
2018	57	213	270
2019	28	152	180
2020	435	3310	3,745
2021	8	410	418

Research

On September 22 and 23, Pacific Northwest National Laboratory (PNNL) personnel released Sensor fish through the fish release control pipe that is mounted on the wall of the tailrace deck by unit 3. They recovered the sensors using boats in the tailrace. Their purpose was to test the performance of the pipe as a suitable control release point, in preparation for the actual biological testing of unit 3 after the new runner is installed.

Avian Predation

Avian Predation-General

Bird monitoring occurred from April 1 to July 31. Gulls, cormorants, Caspian terns, Western grebes and American white pelicans were counted once per day, 6 or 7 days a week from April 1 to June 30 and 4 days (Monday to Thursday) from July 1 to July 31. Areas of avian predation monitoring included: forebay, powerhouse tailrace (two areas), spillway tailrace (three areas), Eagle Island and JFF bypass outfall. Deterrent measures include bird deterrent hydro cannon, bird wires and hazing (April 1 to June 30) under the animal control contract with United States Department of Agriculture-Wildlife Services (USDA-WS).

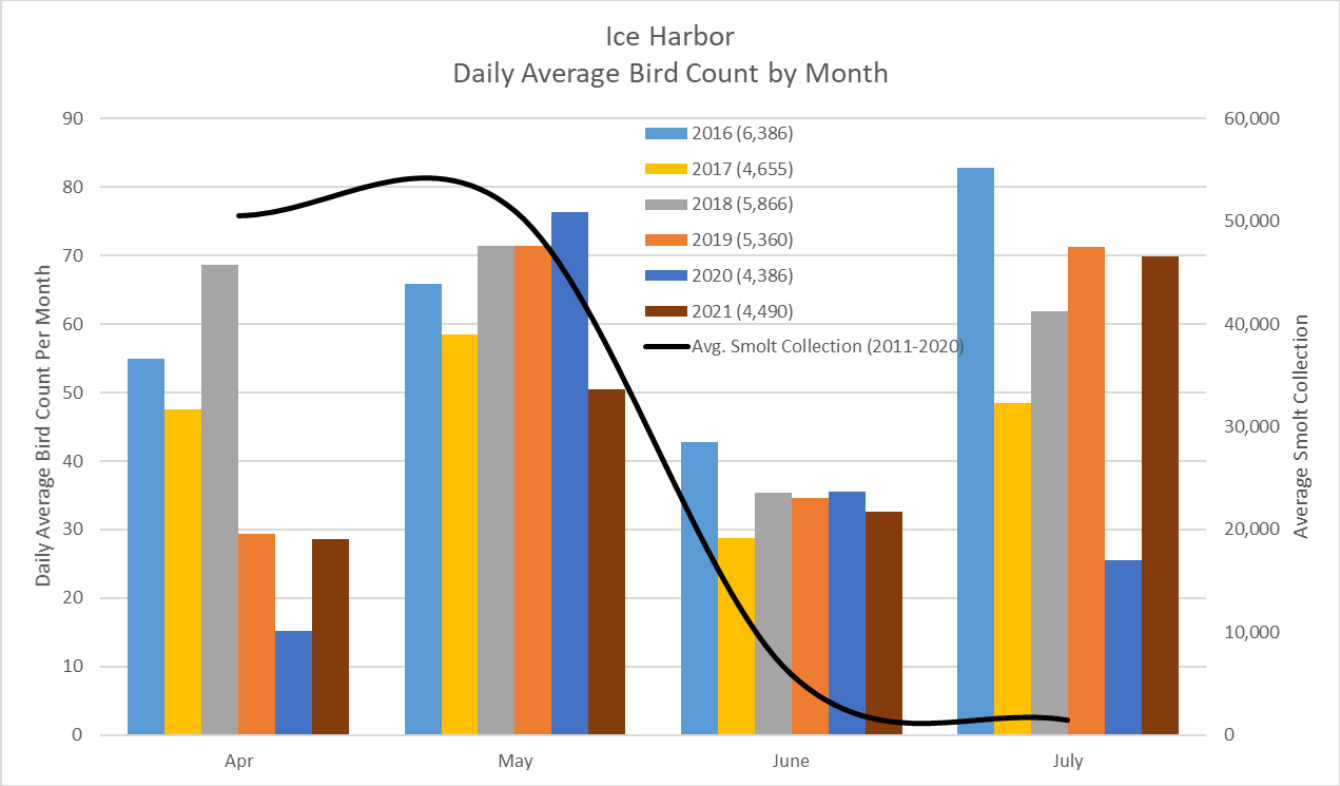

Figure 2. Daily average count at Ice Harbor Dam, 2017-2021.

The hydrocannon pump was turned off for approximately 24 hours on May 12 and 13 to replace a leaky coupling on the hydrocannon water line. There were no birds observed at the outfall pipe during that period. The hydrocannon pump lost power on October 25 and does not automatically restart when power is restored. It was observed to be shut off on October 26 and was immediately turned back on. The bird abatement hydrocannon was out of service for a few hours on September 27 when the breaker was shut off to perform preventative maintenance on other equipment that was powered on the same circuit. On November 16, the fishery biologist noticed that the amount of water shooting out of the hydrocannon at the end of the outfall pipe was significantly reduced. The intake for the hydrocannon pump was plugging with debris and the pump was turned off because of the risk for the pump to burn itself out. No piscivorous birds were seen at the outfall for the remainder of the season. The juvenile fish collection channel and bypass pipe were dewatered for the start of the winter maintenance period on November 18.

Gulls

The highest number of gulls observed in a one-month period for the 2021 season (April 1- July 31) was in the month of May with a total of 875. The highest number observed in one day was 235 on May 16. The decrease may have been related to the hazing which began in April.

The number of gulls feeding in the FB ranged from 0 to 61 birds, while the number of gulls resting in the FB ranged from 0 to 28 birds. The average daily count for foraging and resting gulls seen in the FB was less than 1. The number of gulls seen foraging in SW1 ranged from 0 to 219 and gulls seen resting ranged from 0 to 6. The daily average for gulls seen foraging in SW1 was 2.0. Gulls observed foraging in SW2 was 0 to 412, while gulls seen resting ranged from 0 to 3. The daily average was for gulls seen foraging totaled 3.9 gulls for SW 2. The number of gulls seen foraging in SW3 was 0 to 145, whereas gulls seen resting in SW 3 only ranged from 0 to 3. The daily average of gulls seen foraging in SW3 was 1.4. The daily average for gulls seen resting in SW1, SW2, and SW3 was less than 1. The total of gulls seen foraging in PH1 ranged from 0 to 22, whereas the amount seen nonforaging was 1. The daily average for foraging and nonforaging was less than 1. In PH2, 180 gulls were seen foraging, and 0 to 3 were seen nonforaging. The daily average for foraging gulls seen for PH2 was 1.7, and less than 1 for gulls seen nonforaging. EAIS had 0 to 360 gulls seen foraging and 0 to 28 seen nonforaging. The average seen daily foraging was 3.4, whereas gulls seen nonforaging in this zone was less than 1. Less than 10 percent of all gulls seen in each zone, except the FB, were nonforaging. In the FB, 31 percent of all gulls seen were not foraging.

Gull numbers overall have increased considerably from the 2019 and 2020 season, Figure 2 above. The total amount of gulls observed for 2021 was 1,469, whereas in 2019 the overall total observed was 1,173 and in 2020 the overall total was 348. The total amount observed in 2019 for April was higher than in 2020 and 2021. The total number of gulls observed in April of 2019 was 216. In 2020 the number observed totaled 54 and in April of 2021 the total amount of gulls observed was 95. The number of gulls counted for the month of May in the years 2019, 2020, and 2021 was highest in 2021, totaling 875. The total number of gulls observed for the month of May in 2019 was 434 and for 2020 it was 56. The number of gulls observed for the month of June in 2019 and 2020 were similar. In 2019, the number of gulls observed in June totaled 54, whereas the number of gulls observed in 2020 totaled 17. In 2021, the total number counted

increased greatly from 2019 and 2020, totaling 192. The total number of gulls observed for the month of July was the highest in 2019, totaling 469. The second highest total in July was 306 occurring in 2021. The least number of gulls observed for July in the years listed above was in 2020, totaling 221.

Cormorants

Cormorants counts continued to climb until June in the 2021 season (April 1- July 31). The month of June had the largest overall total count of cormorants seen totaling 241 birds. The largest total for a day however was on May 31 with a total count of 43 birds. In the month of July, they decreased to an overall total of 97 birds.

In the FB the number of cormorants that were seen foraging ranged from 0 to 224 and the number seen resting ranged between 0 to 91. In SW1 the amount seen foraging ranged between 0 and 37, whereas the amount seen resting ranged between 0 to 9. In SW2, 0 to 61cormorants were seen foraging and between 0 and 3 were nonforaging. The amount of cormorant seen foraging in SW3 ranged from 0 to 22. No cormorants in SW3 were seen nonforaging. In PH1 the amount seen foraging ranged between 0 to 49. The range seen in this zone nonforaging was between 0 to 7. Between 0 to 25 were seen foraging in zone PH2 and between 0 and 15 were seen nonforaging. In zone EAIS, between 0 and 58 cormorants were seen foraging and between 0 to 20 were seen nonforaging. In all zones the daily average of cormorant see nonforaging was less than 1. In all zones except for the FB, which had an average of 2.1 cormorant seen foraging, the total cormorant observed foraging was less than 1.

Cormorant numbers decreased from the overall totals observed in the 2019 and 2020 season. The total for 2021 was 621 birds, whereas the overall total for 2019 was 1,419 birds and 762 birds for 2020. The total amount of cormorants for April of 2019 and 2020 was higher than for 2021. The number of cormorants observed in 2019 for April was 399 and in 2020 the number observed was 160. In 2021, the total observed for April was only 110. In the month of May cormorants observed was drastically lower than for 2021. In 2021 the number of birds observed in the month of May was 149, decreasing from May 2019 and 2020. The amount observed in the month of May for 2019 totaled 843 and in 2020 the number observed was 383. The total amount of cormorants observed in June and July of 2019 and 2020 were similar. The number of cormorants observed in 2019 in the month of June totaled 118 and the total amount observed in July was 59. The number of cormorants observed in June of 2020 was 180 and in the month of July the number totaled 39. In 2021, the number of cormorants observed in June and July was higher than in 2019 or 2020. The number observed in June totaled 241 and 97 in July.

Terns

July had the highest overall count of terns, totaling 188 birds for the month. July's highest number of terns observed was on July 7, totaling 39 birds.

In the FB the number of terns foraging ranged between 0 to 10, and 1 was observed not foraging. The number of terns observed in SW1 foraging ranged between 0 to 5, with none being observed not foraging. In SW2 the ranged observed foraging was between 0 to 6, and the number seen not

foraging was between 0 to 5. No terns were observed in zones SW3 and PH1. In PH2, terns seen foraging ranged between 0 to 7, and none were observed not foraging. The number of terns seen foraging in EAIS ranged between 0 to 208, one observed not foraging. In all zones the average daily number of terns not foraging was less than 1. The daily average number of terns seen foraging in all zones, except the EAIS which had a daily average of 2, was less than 1. In all zones, except SW2, the number of terns observed not foraging was less than ten percent.

In 2021, tern numbers increased from what was observed in 2019 and 2020. In 2019 the overall number of terns observed from April to the end of July was 101. The amount observed overall for the same time period in 2020 was 43. The number observed in 2021 from April to the end of July was 242. Though no terns were observed in April of 2020 8 were observed in April of 2019 and 15 were observed in April of 2021. The total amount of terns observed in May was similar in 2019, 2020, and 2021. In 2019 3 were observed, in 2020 5 were observed, and in 2021 6 were observed. In 2019 and 2020 no terns were seen in June, but in 2021 33 were observed. In July of 2019, 93 terns were counted and in July of 2020 33 were counted. The number of terns counted in July of 2021 was much higher than in 2019 and 2020 at 188.

Grebes

Grebes were not observed except for on one day in 2021, July 15, with a total of 9 birds counted.

The total for grebes observed this season was similar to that observed in the 2019 and 2021 season. The overall number observed in 2019 was 12 and the overall number observed in 2021 was 9. However, grebes were seen in more months in 2019 than in 2021. In 2019 they were observed in April, May, and July, whereas in 2021 they were only observed one day in July. The number observed in 2019 for April was 7, in May 2 were observed, in June none were observed and in July 3 were observed. In 2020, no Grebes were observed.

Pelicans

In 2021, American white pelicans were often the most numerous piscivorous bird observed around the dam from April to July. The pelicans could not be targeted for hazing because they are a species of concern in Washington State.

The monthly total of pelican counts in 2021 was the largest in May and then decreased, but each month never deviated by more than 100 birds. The monthly overall total of pelicans for May observed was 934 birds. The largest count for a day in 2021 occurred on May 14, totaling 196 birds.

The number of pelicans observed foraging in the FB ranged between 0 to 53, and the amount observed not foraging ranged between 0 to 16. The average daily number of pelicans foraging and nonforaging in the FB was less than 1. In zone SW1 the range of pelicans seen foraging ranged between 0 to 76, and the amount nonforaging ranged between 0 to 112. The daily average number of pelicans seen foraging was less than 1, however the daily average of pelicans seen in the SW1 not foraging was 1.1. The number of pelicans observed foraging in SW2 ranged between 0 to 140, and the number of pelicans observed not foraging ranged between 0 to 227.

The daily average of pelicans seen foraging in SW2 was 1.3, and the daily average seen not foraging was 2.1. In zone SW3 the number of pelicans observed foraging ranged between 0 to 86, and the amount nonforaging ranged from 0 to 278. Pelicans seen foraging in zone SW3 was rather low, with the daily average in less than 1, however, the daily average of pelicans seen not foraging was 2.1. The number of pelicans observed foraging in zone PH1 ranged between 0 to 47, and the number observed not foraging ranged between 0 to 48. PH1's daily average for pelicans seen foraging and observed not foraging was less than 1. In zone PH2, the number observed foraging ranged between 0 to 85, and the number observed not foraging ranged between 0 to 170. The average daily number of pelicans seen foraging was less than 1, but the average daily number of pelicans seen not foraging was 1.6. The number observed foraging in EAIS ranged between 0 to 556, and the number observed not foraging ranged between 0 to 255. 5.2 was the daily average of pelicans seen foraging in zone EAIS, and the daily average of pelicans observed not foraging was 2.4. The zone with the highest percentage of pelicans seen feeding was the FB (77%), and the second highest sighting of foraging seen was zone EAIS (69%). Making these zones the two lowest zones where nonforaging behavior was observed. The zone with the highest sighting of nonforaging pelicans was SW3(76%), and the second highest sighting of nonforaging behavior was in zone PH2. Therefore, SW3 and PH2 had the lowest sighting of pelicans foraging. SW1, SW2, and PH1 had ranged between 24-30% of pelican seen foraging and between 51-60% seen not foraging. Pelicans were the only bird observed where the percentage foraging (49%), was lower than observed not foraging (51%).

The number of pelicans observed in 2021 (2,139) was lower than for 2019 (2,758) and 2020 (3,146). Monthly pelican counts for April of 2019 and 2020 were similar, ranging around 200, but were significantly lower than for April 2021 at 612. May overall pelican counts were varied for 2019, 2020, 2021. In 2019, the pelican count was 934, in 2020 it was 1,878, and in 2021 it was 934. 2019 and 2020 pelican totals for the month of June was similar, but much higher than for 2021. 2019 and 2020 ranged in the 800s, however, 2021 count was only 492. Lastly, the month of July also varied considerably between 2019, 2020, and 2021. In 2019 the total count of pelicans in July was 792, in 2020 it was 198, and in 2021 it was 516.

Wildlife Services

Land-based hazing of piscivorous birds for 8 hours per day began on April 1 and changed to 16 hours per day on April 4. It was decreased to 7 hours per day on June 6. The land-based hazing ended on June 30. Boat-based hazing for 8 hours per day, 3 days per week, began on April 4 and increased to 5 days per week on April 18. It then was decreased to 3 days a week on May 23 and ended on June 5. Land-based hazing has generally been effective at dispersing birds away from the dam, except for the spillway tailrace zones on windy days. Winds blowing from the south or southwest prevent the shooting of pyrotechnics from the north shore because of the danger of starting a grass fire. Boat-based hazing has been found to be effective at moving birds out of all the tailrace zones, except when turbulent river conditions from spill make it unsafe for the boat to go into the middle tailrace zones to haze birds.

Recommendations for the Juvenile Fish Facility

1. Finish replacing the old deteriorating water regulating weirs and associated connection brackets in the primary dewatering structure.
2. Repaint the interior of the juvenile fish bypass pipe/flume and separator exit flume. The inside surfaces of the pipe and flumes have peeling paint and corroded areas which created rough spots that could possibly descale or injure fish.
3. Extend the air bubbler screen cleaning system under the entire unwatering floor screen in the primary dewatering structure. This system would serve as a reliable extra cleaning system in the event of failure of aging components of the mechanical screen cleaner.
4. Install a crowding mechanism in the juvenile collection channel that would encourage adult fish to exit.
5. Replace the outfall pipe hydrocannon black iron water line with stainless steel to prevent corrosion. Install a walkway alongside the outfall pipe to provide access to the outfall pipe and hydrocannon water line to conduct inspections and maintenance.
6. Install a fish release chute connecting to the main bypass pipe downstream of the JFF lab. This would permit fish rescued during certain unwatering events to be more easily returned to the tailrace via the bypass pipe.
7. Install stairs on the hillside to provide a direct and safe walking path between the JFF and tailrace deck level.
8. Pave the road and parking area inside the JFF and provide curbing that would direct any water runoff away from the juvenile facility and the hillside. Pavement would provide stable ground for heavy equipment access and setup as needed to perform maintenance and repairs.

Adult Fish Facility

Operations and maintenance

The south shore fish ladder (SFL) and north shore fish ladder (NFL) were operated for fish passage for most of the year. The fish ladders were dewatered one at a time for annual winter maintenance in January and February. Adult fish counting started March 1 and ended for the season on October 31. For all species groups the SFL was used much more than the NFL. The total counts for each species group except sockeye, coho, coho jack, and shad, were well below the previous ten years' average (Table 18).

Table 18. Number of adult fish passing Ice Harbor Dam in 2021 and average of previous ten years.

	Chinook	Chinook Jack	Steelhead Clipped	Steelhead Unclip	Sockeye	Coho	Coho Jack	Shad	Lamprey
SFL	32,864	8,184	2,065	949	698	335	60	223,485	161
NFL	11,052	2,186	630	288	256	86	21	20,629	154
Total (SNL + NFL)	43,916	10,370	2,695	1,237	954	421	81	244,114	315
10 YR-Avg (SNL + NFL)	206,805	44,724	191,808	52,607	2,032	36,230	1,367	618,161	1,281

Summary of Fish Recovery Operations

On March 9 during the Ice Harbor Project navigational lock maintenance outage, fish were rescued/salvaged from the dewatered south culvert in the navigational lock. Two small juvenile Chinook salmon, one clipped steelhead (11”), and one walleye (12”) were collected and released in good condition into the forebay at the upstream guide wall. The difference in water temperature between the fish bucket (water from the culvert) and the forebay was 1.4 ºF.

Auxiliary Water Supply

The auxiliary water supply (AWS) pumps were operating or available for operation to help maintain fish entrance criteria in 2021. AWS pumps were turned off, taken OOS, or forced OOS during the fish passage season to facilitate maintenance, operations, or emergency repairs. Five to eight AWS pumps were operated to maintain criteria in the SFL depending on tailwater elevation. Zero to two AWS pumps were operated to maintain criteria in the NFL. In season maintenance and minor repairs can be performed on the pumps that are in standby. Each north shore pump operates at 350 cfs and each south shore pump operates at 30 cfs. In addition, approximately 270 cfs of excess water from the juvenile fish collection channel is added to the south shore AWS pump discharge chamber. Any outages or disruptions that occurred in 2021 are listed below or are cited in (Table 19).

Table 19. AWS pump outages and significant events requiring pumps to be shut off at Ice Harbor Dam, 2021.

Date	Pump Number or How Many Pumps Affected	Pump Outage Description or Reason for Turning Off	Results/Duration OOS
23 March	1,2	Tripped off due to BPQ relays	within 3 hours
7 April	7	Replaced seal in lower gear box	RTS May 3/10 hours 35 minutes
3 May	2	Replaced packing studs	RTS May 4
4 May	4	Replaced seals in lower gear box	RTS May 5
5 May	5	Replaced seals in lower gear box	RTS May 6
6 May	All south shore pumps	Facilitated opening of south shore weirs	2 hours 29 minutes
7 May	All south shore pumps	Facilitated opening of south shore weirs	29 minutes
31 July	2 south shore pumps, all north shore pumps	Loss of power	24 minutes south shore 1 hour north shore
31 July	2 south shore pumps, all north shore pumps	Loss of power	41 minutes south shore 1 hour 21 minutes north shore
2 August	All south and north shore pumps	Loss of power	23 minutes south shore 44 minutes north shore
10 August	2 south shore pumps, 1 of the north shore pumps	Loss of power	17 minutes south shore 45 minutes north shore
October 25	All south and north shore pumps	Loss of power	46 minutes south shore 52 minutes north shore

South shore AWS pump #8 was out of service for winter maintenance and was returned to service on April 5 at 1000 hours. In addition, AWS pumps were turned on April 6 due to channel velocity being low.

All the south shore AWS pumps were turned off from 1440 hours to 1709 hours on June 23, and from 1051 hours to 1120 hours on June 24 to facilitate opening the south shore entrance weirs to fix the problems with SSE-1 weir which a power plant operator noticed was not lowering down and the slack in the operating cable was trailing in the water. During ladder inspection on April 12, it was noticed that the north shore entrance channel/tailwater differential was high, putting it out of criteria. This prompted the Project Biologist to have the power operator turn off one of the 2 AWS pumps. On August 19, the north shore entrance channel/tailwater head differential was below criteria prompting the Project Biologist to turn back on the second pump. The north shore entrance channel/tailwater head differential on August 23 was above criteria to alleviate this the Project Biologist turned off one of the two north shore pumps. September 1, the north shore head differential was below criteria, prompting the operator to turn on the second north shore pump. The differential was rechecked later in the day and was found to be in criteria after the second pump had been turned on. One of the five south shore pumps was turned off on August 12 to alleviate the above criteria readings for the south shore entrance channel/tailwater head differential. On August 26, the Project Biologist noticed that almost no water was flowing over first set of stationary weirs in the south fish ladder upstream of the junction pool. The adjacent set of weirs upstream had about 6” of water depth and the adjacent set downstream had 1-2” depth. This was a result of running only four pumps. Therefore, the fifth pump was turned on.

Adult Fishway Inspections

Visual Inspections

Ice Harbor project fisheries personnel conducted visual inspections of the fish ladders during the adult fish passage season of March 1 to December 31. In addition, powerhouse operators conducted daily limited inspections of the fishways. Fish facility staff averaged three fishway inspections per week with 128 inspections completed. The inspections were conducted by visually inspecting various areas of the fishways and recording reading from staff gauges, fishway entrance hoist motors, meters and tape measures. The data was subsequently transferred to a computer spreadsheet, see Appendix 1. Fisheries staff also collected data on flow discharge, AWS pump operation and juvenile fish orifice operation. In addition, the amount of debris that accumulated in the forebay, fish ladder exits, and gatewells were estimated. When the fishway was out of criteria, the powerhouse operator was notified to make any needed adjustments to the fishway control system or arrange for repairs as needed. The combined fish passage data collected was used to compose weekly reports on the status of the fish facility operation and maintenance. The lamprey passage structure at the south shore entrance #2 (SFE-2) was opened on June 30 and closed October 4 for the adult lamprey passage season. The north ladder was dewatered from February 1 to February 25 and the south ladder was dewatered from January 4 to January 27.

Automated Fishway Control Systems

Inspection Results

Channel Velocity

The water velocity in the south shore channel junction pool was in criteria [criteria of 1.5-4.0 feet per second (fps)] on 96.9% of the inspections. When the tailwater and channel elevations are higher during periods of high river flows, more of the stationary weirs in the fish ladder are submerged, slowing the velocity of the water coming down the ladder into the junction pool. The out of criteria readings ranged from 0.7 to 1.4 fps.

The south shore channel velocity was below criteria on March 11. The powerhouse operator was informed, and he lowered NFE-2 weir to increase the velocity. The south shore channel velocity was slightly below criteria on April 6, an additional south shore auxiliary water supply pump was turned on to increase the velocity.

Ladder Exits

The north and south fish ladder exit head differentials were in criteria (<0.3 feet) during all inspections. There were no significant debris accumulations on the ladder exit trash racks causing the differentials to get above 0.2'. Picketed leads were put down March 31.

On April 13, the south shore fish ladder exit debris boom was found to be detached at a connection midway between the booms. One half of the log booms is against the south shore upstream of the ladder exit and the other half is against the dam between unit 1 and the south shore ladder exit. Water turbulence in the forebay from an east wind caused the logs to break loose. The debris boom will be repaired when winds calm down to allow safe forebay access with a work boat. Fortunately, there is currently very little debris in the forebay.

Between August 6 and 12 the south fish ladder picketed leads at the count station began consistently being cleaned of filamentous algae daily to keep the differential within criteria.

Ladder Weirs

The depth over the stationary weirs in both fish ladders were in criteria (1.0-1.3 feet) 99.2% of fishway inspections. In the south shore weirs, it was only out of criteria in one instance. In that instance it was below criteria by > 0.2. The north shore weirs were also out of criteria once out of the 128 inspections. In that instance it was below criteria by ≤ 0.2 feet.

Counting Stations

The differential across the north shore picketed leads were in criteria (<0.3 feet) on all inspections. The differential across the south shore picketed leads was out of criteria (criteria of >0.2 feet) on one inspection.

South Shore Entrance

The SFE-1 weir gate depth was in criteria (> 8 feet or on sill) 93.7% of the inspections. The weir gate was in sill criteria on 56.3% of inspections.

SFE-1 weir depth was observed to be slightly under criteria on March 31 and April 1. Operations set SFE-1 weir on automatic control, and the powerhouse operator increased the set point for the weir depth to bring it back criteria.
The south shore channel/tailwater differential was above criteria on June 22, and the north powerhouse entrance weir depth was slightly below criteria on June 22 and 24. The powerhouse operator was asked to lower NFE-2 weir down to sill on June 22 to help bring those inspection points into criteria, but he probably forgot to do that.

In the early afternoon of June 23, the powerhouse operator noticed that SFE-1 weir was not lowering down and the slack in the operating cable was trailing in the water. Water pressure against the weir was preventing it from moving down in the guide slot. The operator turned all of the south shore auxiliary water supply (AWS) pumps off to reduce the water pressure and lower the weir. Electricians found that in the process of lowering the weir, the coil in the braking system had burned out. The operator opened SFE-2 and closed SFE-1 for repair. The AWS pumps were then turned back on. On June 24, electricians replaced the brake coil, then the operator put SFE-1 weir back in service in the late morning and closed SFE-2.

The south shore entrance (SFE-1) weir depth was out of criteria (7.9') for the fishway inspection conducted on July 22. The depth was corrected shortly after the fishway inspection was conducted to meet the criteria depth of eight feet.

On August 26, the Project Biologist noticed that there was almost no water flowing over one set of the stationary weirs in the south fish ladder upstream of the junction pool (1.0'-1.3' criteria). The adjacent set of weirs upstream had about 6" of water depth and the adjacent set downstream had 1"-2" of depth. This was the result of operating only four south shore AWS pumps, which must not create enough head from the pump discharge chamber to fill all of the diffuser chambers in the fish ladder. A fifth pump was started up on August 26 to rectify the situation. The depth over the weirs upstream of the junction pool in the south fish ladder was most likely below criteria for the entire time that four pumps were operating, which was July 31 to August 2, and August 12 to August 26. A minimum of five south shore auxiliary water supply pumps needs to be operating to maintain the depth over the stationary weirs in the lower part of the fish ladder, so another pump cannot be shut off to lower the head differential at the entrance,

North Powerhouse Entrance

The NEW-1 weir gate was in criteria (>8 feet or on sill) on 96.1% of inspections. The weir gate was in sill criteria on 58.6% of inspections, primarily when tailwater was lower from mid-summer to the end of the year.

The north powerhouse entrance weir depth was below criteria on April 5 when the weir was slightly off sill. The powerhouse operator was informed, and he lowered NEW-1 weir down to sill.

North Shore Entrance

The NSE was in criteria 98.4% of inspections. The weir gate was in sill criteria on 72.7% of inspections. From April 12 to September 1 the north shore head differential criteria was unable to be consistently met due to the fluctuations with the AWS pumps. See AWS section in this report for more information

The north shore channel/tailwater differential was below criteria on March 31 and April 1. The operator was informed, and he raised NEW-1 weir to bring the differential into criteria while keeping the weir depth in criteria.

The powerhouse operator was asked to lower NFE-2 weir down to sill on June 22 to help bring those inspection points into criteria.

Fish Collection Channel and Tailwater Head Differential

South Shore Entrance

The south shore entrance channel/tailwater head differential was in criteria (1- 2 feet) on 82.8% of inspections. In the inspections it was out of criteria the differentials were above the standard.

In 16 of the out of criteria inspection it was above by > 0.2 feet. Five of the inspections it was within 0.11-0.2 feet and in the remaining ladder inspection where it was above criteria it was within 0.01-0.11 feet.

The south shore channel/tailwater differential was above criteria on May 25. The powerhouse operator was informed, and he increased the set point for the SFE1 weir depth.

The south shore channel/tailwater differential was found to be 2.3 feet for the July 8 fishway inspection. No actions could be taken to correct the differential criteria found from both fishway inspections. The gates for the channel were on sill on both dates, and the revolutions per minute of the north and south fish ladder pumps are constant and cannot be reduced. In addition, the minimum number of pumps were being operated.

The south shore channel/tailwater differential was above criteria on June 22, and the north powerhouse entrance weir depth was slightly below criteria on June 22 and 24 and lowering NFE-2 weir down to sill corrected the criteria.

The south shore entrance channel/tailwater differentials were above criteria on the fishway inspections conducted on July 28 and 29, respectively. The differential was monitored for further high readings.

The south shore channel/tailwater differential was above criteria on May 25. The powerhouse operator was informed, and he increased the set point for the SFE1 weir depth. The south shore entrance channel/tailwater head differential was above criteria on July 13 and 15, August 17 through September 2, September 9, September 13 through September 23. fish ladder inspections. Only four south shore auxiliary water supply (AWS) pumps were operating since August 12 to decrease the reoccurring high head differential, but the low tailwater elevation still caused the high readings. The pump speed is not adjustable to make small changes to the water supply to help meet head criteria at the entrances. The south shore channel/tailwater differential was above criteria on June 22, and the north powerhouse entrance weir depth was slightly below criteria on June 22 and 24. The powerhouse operator was asked to lower NFE-2 weir down to sill on June 22 to help bring those inspection points into criteria.

North Powerhouse Entrance

The north powerhouse entrance head differential was in criteria (1-2 feet) on 96.1% of inspections. The inspections where it was not in criteria it fell below criteria by > 0.2 feet.

The north shore entrance channel/tailwater differentials were above criteria on the fishway inspections conducted on July 28 and 29, respectively. The differential was monitored for further high readings.

The north shore entrance channel/tailwater differential was above criteria on the fishway inspections conducted on August 2 and 3. The decision was made to monitor the differential for further high readings. The north shore channel/tailwater differential was above criteria on

October 12. The high head differentials were caused by the low tailwater elevations during the week.

The north shore entrance channel/tailwater differential was above criteria on August 2, 3, and December 2. The high head differential seen on these dates was caused by low tailwater elevation. Two auxiliary water supply pumps are routinely operated for the north fish ladder and the entrance head would most likely be under criteria with only one pump running. The auxiliary water supply pump speed is not adjustable to reduce the entrance head.

North Shore Entrance

The north shore entrance head differential was in criteria (1-2 feet) on 85.2% of inspections. The deviations from criteria consisted of higher and lower depth readings. In the nine inspections where it was above criteria it ranged within 0.11-0.2 feet for three and > 0.2 for the remaining six. For the 10 inspections where it was below criteria, it was > 0.2 feet for seven and within 0.01-0.1 for three.

The north shore channel/tailwater differential was below criteria on June 10, which may have resulted from the turbulent tailwater conditions from spill making it difficult to get an accurate tailwater staff gauge reading.

The north shore channel/tailwater differential was found to be 2.3 feet for the July 6 fishway inspection. No actions could be taken to correct the differential criteria found from both fishway inspections. The gates for the channel were on sill on both dates, and the revolutions per minute of the north and south fish ladder pumps are constant and cannot be reduced. In addition, the minimum number of pumps were being operated.

The north shore head differential in 2021 criteria was unable to be consistently met. This impacted inspections on April 14, August 9, August 10, August 12, and August 23 which caused the project biologist to turn off one of the north shore auxiliary pumps. On August 19 and September1 the differential was below criteria causing the decision for the AWS pump that had been turned off to be turned back on, see the AWS section of this report for more information.

Table 20. Adult Fishway Inspection Results at Ice Harbor Dam, 2021.

ICE HARBOR Criteria and Locations	No. in Criteria/ No. on Sill/ No. of Inspections	% In Criteria/ % On Sill	No./% Within 0.01-0.1 Foot	---------- Not Enough Depth---- ------ No./% Within 0.11-0.2 Foot	No./% >0.2 Foot	No./% Within 0.01-0.1 Foot	---------- Too Much Depth---- ------ No./% Within 0.11-0.2 Foot	No./% >0.2 Foot
Channel Velocities	124	96.9	***	***	***	***	***	***
	***	***	***	***	***	***	***	***
	128							
Differentials								
South Fish Ladder								
Ladder Exit	128	100.0	***	***	***	0	0	0
	***	***	***	***	***	0.0	0.0	0.0
	128							
Ladder Weirs	127	99.2	0	0	1	0	0	0
	***	***	0.0	0.0	0.8	0.0	0.0	0.0
	128							
Counting Station	127	99.2	***	***	***	0	0	1
	***	***	***	***	***	0.0	0.0	0.8
	128							
North Fish Ladder								
Ladder Exit	128	100.0	***	***	***	0	0	0
	***	***	***	***	***	0.0	0.0	0.0
	128							
Ladder Weirs	127	99.2	0	1	0	0	0	0
	***	***	0.0	0.8	0.0	0.0	0.0	0.0
	128							
Counting Station		0.0	***	***	***	0	0	0
	***	***	***	***	***	0.0	0.0	0.0
	128							
Collection Channels								
South Shore	106	82.8	0	0	0	1	5	16
	***	***	0.0	0.0	0.0	0.8	3.9	12.5
	128							
North Powerhouse	123	96.1	0	0	2	0	0	3
	***	***	0.0	0.0	1.6	0.0	0.0	2.3
	128							
North Shore	109	85.2	3	0	7	0	3	6
	***	***	2.3	0.0	5.5	0.0	2.3	4.7
	128							
Weir Depths								
SFE 1	48	37.5	6	1	0	***	***	***
	72	56.3	4.7	0.8	0.0	***	***	***
	128							
NFE 2	48	37.5	0	0	0	***	***	***
	75	58.6	0.0	0.0	0.0	***	***	***
	128							
NSE 1	33	25.8	2	4	2	***	***	***
	93	72.7	1.6	3.1	1.6	***	***	***
	128							

Recommendations for the Adult Fish Facility

1. Continue to repair south fish ladder mud valves in the auxiliary water supply conduit to facilitate unwatering the lower ladder for inspection and maintenance.
2. Remove the accumulated silt in the south shore AWS conduit that is clogging the mud valves and blocking access to some of the mud valves and sluice gates for inspection and maintenance.
3. Rehabilitate fish ladder entrance weir gates and hoisting equipment.
4. Install a handrail along the outside edge of the north and south shore fish ladders to allow routine in-season inspection of the entire fish ladders and to facilitate safer unwatering and fish evacuation procedures for personnel.
5. Replace the debris booms and attachment systems at the north and south shore fish ladder exits. The log booms are prone to detachment under high winds.
6. Proactively replace fish ladder diffuser grating as needed.
7. Replace broken/dirty staff gauges and guides so that the gauges are easier to clean and read.
8. Relocate staff gages and transducer units as needed so the staff gage and the automated fishway control system readings will be more precise.
9. Install an audible alert on the automated control system PLC when the fish ladder entrance criteria are not being met.
10. Initiate a contract to repair leaks in the fish ladder joints.